

CLAIMS:

1. A rocking mechanism through which linear reciprocating movement of a piston of an internal combustion engine can be transferred, from the remote end of a con rod on which the piston is mounted, to a crankshaft; wherein the rocking mechanism includes:
- a rocking member;
 - mountings by which the rocking member is mountable, on a structure of or secured to a crankcase for the engine, for reversible rocking movement on a first axis;
 - a link member pivotally connected, at one of opposite ends thereof, to the rocking member so as to be pivotable relative to the rocking member on a second axis, offset from and parallel to the first axis, between two extreme positions; and
 - holding and adjusting means (hereafter referred to as "holding means") by which the link member is releasably holdable in either of the two extreme positions; and
- wherein at its other end, the link member is adapted for pivotably connecting to the remote end of con rod so as to be pivotable relative to the con rod on a third axis which is offset from the second axis and parallel to the first and second axes and, at a location offset from the first axis, the rocking member is adapted for pivotally connecting to a little end of a further con rod, having a big end connectable to the crankshaft, for relative rotation between the rocking member and the further con rod on a fourth axis parallel to the first, second and fourth axes.
2. The rocking mechanism of claim 1, wherein the rocking member has at least one plate member with the first and second axes extending normal to and through the at least one plate member.
3. The rocking mechanism of claim 1, wherein the rocking member has at least two mutually spaced, substantially parallel plate members with the first and second axes extending normal to and through each of the plate members.

4. The rocking mechanism of any one of claims 1 to 3, wherein the mountings comprise a pair of axle members or trunnion pins each integral with and extending oppositely from the rocking member and each with an axis on the first axis.
- 5 5. The rocking mechanism of any one of claims 1 to 3, wherein the mountings comprise openings defined by the rocking member or by fittings secured to the rocking member, by which the rocking member is adapted to receive an axle or a shaft or a respective axle or shaft extending from an adjacent structure of, or secured to, the engine crankcase.
- 10 6. The rocking mechanism of any one of claims 1 to 3, wherein the mountings include an axle or shaft extending through the rocking member and adapted to extend through a further rocking member of a further adjacent rocking mechanism.
- 15 7. The rocking mechanism of any one of claims 1 to 6, wherein the link member is of elongate form and adapted for pivotable coupling at each end.
8. The rocking mechanism of claim 7, wherein the link member comprises a
20 single elongate bar.
9. The rocking mechanism of claim 7, wherein the link member comprises a parallel pair of laterally spaced elongate bars.
- 25 10. The rocking mechanism of claim 7, wherein the link member is forked in comprising a parallel pair of elongate arms, joined at an end of each arm at which the link member is connectable to the rocking member at the second axis.
- 30 11. The rocking mechanism of claim 10, wherein the arms are joined at said end of each by a cylindrical web or boss by which the link member is able to be connected to the rocking member by a pin extending through each of the web or boss and the rocking member.

12. The rocking mechanism of any one of claims 1 to 11, wherein the holding means is a device operable to hold the link member at a selected one of two extreme positions between which the link member is pivotable relative to the rocking member.

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13. The rocking mechanism of claim 12, wherein the rocking member defines at least one stop at which the holding means is operable to hold the link member in one of the extreme positions.

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14. The rocking mechanism of claim 12, wherein at least one of the two extreme positions is defined by a limit of movement of the holding means.

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15. The rocking mechanism of claim 12, wherein the rocking member has or defines at least one abutment or stop for preventing pivoting of the link member relative to the rocking member beyond one of the extreme positions.

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16. The rocking mechanism of any one of claims 1 to 11, wherein the holding means is a device operable to hold the link member at any required position at one of or intermediate two extreme positions between which the link member is pivotable relative to the rocking member.

17. The rocking mechanism of any one of claims 1 to 16, wherein the holding means is a device operable by mechanical and/or hydraulic means.

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18. The rocking mechanism of claim 17, wherein the holding means is a double acting hydraulic ram which extends across or within the rocking member, laterally with respect to the link member.

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19. The rocking mechanism of claim 18, wherein the ram has one end pivotably connected to the rocking member and its other end pivotably connected to the link member whereby the ram is operable to pivot the link member on the second axis by extending and retracting.

20. The rocking mechanism of claim 19, wherein the other end of the ram is pivotably connected to the link member intermediate the second and third axes.

21. The rocking mechanism of any one of claims 1 to 3, wherein the mountings
5 comprise an opening defined by the rocking member or by a fitting secured to the rocking member; and wherein the holding means includes an adjusting shaft or axle having an axis co-incident with the first axis on which it is rotatable relative to the rocking member, an eccentric rotatable with the adjusting shaft or axle to orbit around the first axis and a holding arm which is journalled at one end on the
10 eccentric and extends therefrom radially with respect to the first axis to a pivotable coupling between its other end and the link member, whereby the holding arm is moved with orbiting of the eccentric in response to rotation of the adjusting shaft or axle to pivot the link member on the second axis relative to the rocking member.

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22. The rocking mechanism of claim 21, wherein the adjusting shaft or axle forms part of an hydraulic actuator which includes a housing into which the adjusting shaft or axle extends, the actuator further including a vane which extends radially from the adjusting shaft or axle within a chamber defined by the
20 housing, with the housing adapted for the supply of hydraulic fluid to the chamber for causing the vane to sweep arcuately in the chamber and thereby rotate the adjusting shaft.

23. The rocking mechanism of claim 21, wherein the housing is adapted for the
25 supply of hydraulic fluid to a selected one of two regions of the chamber for causing the vane to sweep and thereby rotate the adjusting shaft in a required direction.

24. The rocking mechanism of any one of claims 1 to 12, wherein the link
30 member is pivotable relative to the rocking member on said second axis by means of a pin which is journalled in the rocking member and to which the one end of the link member is non-rotatably engaged or secured; the pin forms part of a hydraulic actuator which comprises the holding means, the actuator further including a vane which extends radially from the pin within a chamber defined by or on the rocking

member in which the vane is able to sweep arcuately with rotation of the pin, and means by which hydraulic fluid is able to be supplied to the chamber for moving the vane to and holding the vane in one of two extreme positions.

5 25. The rocking mechanism of claim 24, wherein the hydraulic fluid is able to be supplied to move the vane to and hold the vane in a selected one of the two extreme positions.

10 26. The rocking mechanism of claim 23, wherein the hydraulic fluid is able to be supplied to move the vane to and hold the vane in only one of the two extreme positions, against the bias of a spring acting to move the vane to and hold the vane in the other extreme position as hydraulic fluid is released from the chamber.

15 27. The rocking mechanism of any one of claims 1 to 26, wherein the spacing between the first and second axes is the same as the spacing between the second and third axes, and the link member is pivotable on the second axis to a position in which the first and third axes are co-incident.

20 28. The rocking mechanism of any one of claims 1 to 27, wherein the rocking member is adapted for pivotally connecting to the little end of the further con rod on the fourth axis at a location at which the second and fourth axes are co-incident.

25 29. The rocking mechanism of any one of claims 1 to 28, wherein the locking mechanism is adapted for use in an engine having a V-type configuration in which the piston its con rod connected to the link member is for a cylinder of one bank of cylinders, by the rocking member being adapted at a location spaced from the first, second, third and fourth axes for pivotable connection to the remote end of a con rod for a piston for a cylinder of the other bank of cylinders.

30 30. An internal combustion (IC) engine having a cylinder head and a crankcase, a plurality of cylinders defined by the cylinder head, a crankshaft journaled in the crankcase for rotation on a longitudinal axis of rotation, a respective piston in each cylinder, and a respective con rod on one end of which

each piston is mounted and from the remote end of which each piston is connected to the crankshaft for transferring linear reciprocation movement of each piston in its cylinder to, and for rotating, the crankshaft; the engine further includes, for at least one cylinder, a rocking mechanism through which the con rod (hereinafter referred to as the "first con rod"), on which the piston of the one cylinder is mounted, is connected to the crankshaft; wherein the rocking mechanism includes:

- a rocking member;
- mountings by which the rocking member is mounted, on a structure of or secured to a crankcase for the engine, for reversible rocking movement on a first axis parallel to the crankshaft axis;
- a link member pivotally connected, at one of opposite ends thereof, to the rocking member so as to be pivotable relative to the rocking member on a second axis, offset from and parallel to the first axis, between two extreme positions; and
- holding and adjusting means (hereafter referred to as "holding means") by which the link member is releasably holdable in either of the two extreme positions;

wherein the other end of the link member is pivotally connected to the remote end of the first con rod so as to be pivotable relative to the first con rod on a third axis offset from and parallel to the first and second axes; the rocking member is pivotally connected to a little end of a second con rod having a big end journalled on the crankshaft, for relative rotation between the rocking member and the second con rod on a fourth axis parallel to the first, second and third axes; the first and second con rods are movable in the same plane or parallel planes and the first, second, third and fourth axes are parallel to the axis of rotation of the crankshaft; and wherein the arrangement is such that, with the holding means holding the link member, linear reciprocating motion of the piston of the one cylinder is able to be transferred to the crankshaft and rotate the crankshaft, by the resultant motion of the first con rod being transferred to the second con rod by rocking motion of the rocking member on the first axis, by pivoting of the link member relative to the first con rod on the third axis, and by pivoting of the rocking member relative to the second con rod on the fourth axis.

31. The IC engine of claim 30, wherein the rocking member has at least one plate member with the first and second axes extending normal to and through the at least one plate member.
- 5 32. The IC engine of claim 30, wherein the rocking member has at least two mutually spaced, substantially parallel plate members with the first and second axes extending normal to and through each of the plate members.
- 10 33. The IC engine of any one of claims 30 to 32, wherein the mountings comprise a pair of axle members or trunnion pins each integral with and extending oppositely from the rocking member, each with an axis on the first axis and journaled in a structure of or secured to the crankcase.
- 15 34. The IC engine of any one of claims 30 to 32, wherein the mountings comprise openings defined by the rocking member or by fittings secured to the rocking member, in which the rocking member has received an axle or a shaft or a respective axle or shaft extending from an adjacent structure of, or secured to, the crankcase.
- 20 35. The IC engine of any one of claims 30 to 32, wherein the mountings include an axle or shaft extending through the rocking member and through a further rocking member of at least one further adjacent rocking mechanism for at least one piston.
- 25 36. The IC engine of any one of claims 30 to 35, wherein the link member is of elongate form.
- 30 37. The IC engine of claim 36, wherein the link member comprises a single elongate bar.
38. The IC engine of claim 36, wherein the link member comprises a parallel pair of laterally spaced elongate bars.

39. The IC engine of claim 36, wherein the link member is forked in comprising a parallel pair of elongate arms, joined at an end of each arm at which the link member is connected to the rocking member at the second axis.
- 5 40. The IC engine of claim 39, wherein the arms are joined at said end of each by a cylindrical web or boss by which the link member is connected to the rocking member by a pin extending through each of the web or boss and the rocking member.
- 10 41. The IC engine of any one of claims 30 to 40, wherein the holding means is a device operable to hold the link member at a selected one of two extreme positions between which the link member is pivotable relative to the rocking member.
- 15 42. The IC engine of claim 41, wherein the rocking member defines at least one stop at which the holding means is operable to hold the link member in one of the extreme positions.
- 20 43. The IC engine of claim 41, wherein at least one of the two extreme positions is defined by a limit of movement of the holding means.
- 25 44. The IC engine of claim 41, wherein the rocking member has or defines at least one abutment or stop for preventing pivoting of the link member relative to the rocking member beyond one of the extreme positions.
- 30 45. The IC engine of any one of claims 30 to 40, wherein the holding means is a device operable to hold the link member at any required position at one of or intermediate two extreme positions between which the link member is pivotable relative to the rocking member.
46. The IC engine of any one of claims 30 to 45, wherein the holding means is a device operable by mechanical and/or hydraulic means.

47. The IC engine of claim 46, wherein the holding means is a double acting hydraulic ram which extends across or within the rocking member, laterally with respect to the link member.

5 48. The IC engine of claim 47, wherein the ram has one end pivotably connected to the rocking member and its other end pivotably connected to the link member whereby the ram is operable to pivot the link member on the second axis by extending and retracting.

10 49. The IC engine of claim 48, wherein the other end of the ram is pivotably connected to the link member intermediate the second and third axes.

50. The rocking mechanism of any one of claims 1 to 3, wherein the mountings comprise an opening defined by the rocking member or by a fitting secured to the
15 rocking member; and wherein the holding means includes an adjusting shaft or axle having an axis co-incident with the first axis on which it is rotatable relative to the rocking member, an eccentric rotatable with the adjusting shaft or axle to orbit around the first axis and a holding arm which is journaled at one end on the eccentric and extends therefrom radially with respect to the first axis to a pivotable
20 coupling between its other end and a lug extending from the remote end of the first con rod offset and parallel to the third axis. The remote end of the first con rod is pivotally connected to the link member at the third axis, whereby the holding arm is moved with orbiting of the eccentric in response to rotation of the adjusting shaft or axle to cause the link member to pivot on the second axis relative to the
25 rocking member.

51. The IC engine of any one of claims 1 to 3, wherein the mountings comprise an opening defined by the rocking member or by a fitting secured to the rocking member; and wherein the holding means includes an adjusting shaft or axle
30 having an axis co-incident with the first axis on which it is rotatable relative to the rocking member, an eccentric rotatable with the adjusting shaft or axle to orbit around the first axis and a holding arm which is journaled at one end on the eccentric and extends therefrom radially with respect to the first axis to a pivotable coupling between its other end and the link member, whereby the holding arm is
35 moved with orbiting of the eccentric in response to rotation of the adjusting shaft

or axle to pivot the link member on the second axis relative to the rocking member.

52. The IC engine of claim 51, wherein the adjusting shaft or axle forms part of an hydraulic actuator which includes a housing defined by the rocking member and into which the adjusting shaft or axle extends, the actuator further including a vane which extends radially from the housing within a chamber defined by the housing and the adjusting shaft with the housing adapted for the supply of hydraulic fluid to the chamber for causing the adjusting shaft to rotate and the chamber to sweep arcuately relative to the vane.

53. The IC engine of claim 52, wherein the housing is adapted for the supply of hydraulic fluid to a selected one of two regions of the chamber for causing the adjusting shaft to rotate in a required direction.

54. The IC engine of any one of claims 30 to 41, wherein the link member is pivotable relative to the rocking member on said second axis by means of a pin which is journaled in the rocking member and to which the one end of the link member is non-rotatably engaged or secured; the pin forms part of a hydraulic actuator which comprises the holding means, the actuator further including a vane which extends radially from the pin within a chamber defined by or on the rocking member in which the vane is able to sweep arcuately with rotation of the pin, and means by which hydraulic fluid is able to be supplied to the chamber for moving the vane to and holding the vane in one of two extreme positions.

55. The IC engine of claim 54, wherein the hydraulic fluid is able to be supplied to move the vane to and hold the vane in a selected one of the two extreme positions.

56. The IC engine of claim 53, wherein the hydraulic fluid is able to be supplied to move the vane to and hold the vane in only one of the two extreme positions, against the bias of a spring acting to move the vane to and hold the vane in the other extreme position as hydraulic fluid is released from the chamber.

57. An internal combustion (IC) engine having a cylinder head and a crankcase, a plurality of cylinders defined by the cylinder head in an in-line configuration, a crankshaft journaled in the crankcase for rotation on a longitudinal axis of rotation, a respective piston in each cylinder, and a respective con rod on one end of which each piston is mounted and from the remote end of which each piston is connected to the crankshaft for transferring linear reciprocation movement of each piston in its cylinder to, and for rotating, the crankshaft; the engine further includes, for each of at least two cylinders, a respective rocking mechanism through which the con rod (hereinafter referred to as the "first con rod"), on which the piston of each of the at least two cylinders is mounted, is connected to the crankshaft; wherein the rocking mechanism includes:

- a rocking member;
- mountings by which the rocking member is mounted, on a structure of or secured to a crankcase for the engine, for reversible rocking movement on a first axis parallel to the crankshaft axis;
- a link member pivotally connected, at one of opposite ends thereof, to the rocking member so as to be pivotable relative to the rocking member on a second axis, offset from and parallel to the first axis, between two extreme positions; and
- holding and adjusting means (hereinafter referred to as "holding means") by which the link member is releasably holdable in either of the two extreme positions;

wherein the other end of the link member is pivotally connected to the remote end of the first con rod so as to be pivotable relative to the first con rod on a third axis offset from and parallel to the first and second axes; the rocking member is pivotally connected to a little end of a second con rod having a big end journaled on the crankshaft, for relative rotation between the rocking member and the second con rod on a fourth axis parallel to the first, second and third axes; the first and second con rods are movable in the same plane or parallel planes and the first, second, third and fourth axes are parallel to the axis of rotation of the crankshaft; and wherein the arrangement is such that, with the holding means holding the link member, linear reciprocating motion of the piston of the one cylinder is able to be transferred to the crankshaft and rotate the crankshaft, by

the resultant motion of the first con rod being transferred to the second con rod by rocking motion of the rocking member on the first axis, by pivoting of the link member relative to the first con rod on the third axis, and by pivoting of the rocking member relative to the second con rod on the fourth axis; and wherein the holding means for each of the at least two cylinders is operable to pivot the link member to bring its fourth axis into co-incidence with the first axis and thereby enable its piston to be de-activated.

58. An internal combustion (IC) engine having a cylinder head and a crankcase, a plurality of cylinders defined by the cylinder head in an in-line configuration, a crankshaft journaled in the crankcase for rotation on a longitudinal axis of rotation, a respective piston in each cylinder, and a respective con rod on one end of which each piston is mounted and from the remote end of which each piston is connected to the crankshaft for transferring linear reciprocation movement of each piston in its cylinder to, and for rotating, the crankshaft; the engine further includes, for each cylinder, a respective rocking mechanism through which the con rod (hereinafter referred to as the "first con rod"), on which the piston of each cylinder is mounted, is connected to the crankshaft; wherein each rocking mechanism includes:

- a rocking member;
- mountings by which the rocking member is mounted, on a structure of or secured to a crankcase for the engine, for reversible rocking movement on a first axis parallel to the crankshaft axis;
- a link member pivotally connected, at one of opposite ends thereof, to the rocking member so as to be pivotable relative to the rocking member on a second axis, offset from and parallel to the first axis, between two extreme positions; and
- holding and adjusting means (hereafter referred to as "holding means") by which the link member is releasably holdable in either of the two extreme positions;

wherein the other end of the link member is pivotally connected to the remote end of the first con rod so as to be pivotable relative to the first con rod on a third axis offset from and parallel to the first and second axes; the rocking member is pivotally connected to a little end of a second con rod having a big end journaled

on the crankshaft, for relative rotation between the rocking member and the second con rod on a fourth axis parallel to the first, second and third axes; the first and second con rods are movable in the same plane or parallel planes and the first, second, third and fourth axes are parallel to the axis of rotation of the crankshaft; and wherein the arrangement is such that, with the holding means holding the link member, linear reciprocating motion of the piston of the one cylinder is able to be transferred to the crankshaft and rotate the crankshaft, by the resultant motion of the first con rod being transferred to the second con rod by rocking motion of the rocking member on the first axis, by pivoting of the link member relative to the first con rod on the third axis, and by pivoting of the rocking member relative to the second con rod on the fourth axis; and wherein the holding means for each rocking mechanism is operable in unison with each other holding means to vary the stroke of each piston between two extreme settings.

59. An internal combustion (IC) engine having a cylinder head and a crankcase, a plurality of cylinders defined by the crankcase cylinder head in an in-line configuration, a crankshaft journaled in the crankcase for rotation on a longitudinal axis of rotation, a respective piston in each cylinder, and a respective con rod on one end of which each piston is mounted and from the remote end of which each piston is connected to the crankshaft for transferring linear reciprocation movement of each piston in its cylinder to, and for rotating, the crankshaft; the engine further includes, for each cylinder, a respective rocking mechanism through which the con rod (hereinafter referred to as the "first con rod"), on which the piston of each cylinder is mounted, is connected to the crankshaft; wherein each rocking mechanism includes:

- a rocking member;
- mountings by which the rocking member is mounted, on a structure of or secured to a crankcase for the engine, for reversible rocking movement on a first axis parallel to the crankshaft axis;
- a link member pivotally connected, at one of opposite ends thereof, to the rocking member so as to be pivotable relative to the rocking member on a second axis, offset from and parallel to the first axis, between two extreme positions; and

- holding and adjusting means (hereafter referred to as "holding means") by which the link member is releasably holdable in either of the two extreme positions;

wherein the other end of the link member is pivotally connected to the remote end of the first con rod so as to be pivotable relative to the first con rod on a third axis offset from and parallel to the first and second axes; the rocking member is pivotally connected to a little end of a second con rod having a big end journalled on the crankshaft, for relative rotation between the rocking member and the second con rod on a fourth axis parallel to the first, second and third axes; the first and second con rods are movable in the same plane or parallel planes and the first, second, third and fourth axes are parallel to the axis of rotation of the crankshaft; and wherein the arrangement is such that, with the holding means holding the link member, linear reciprocating motion of the piston of the one cylinder is able to be transferred to the crankshaft and rotate the crankshaft, by the resultant motion of the first con rod being transferred to the second con rod by rocking motion of the rocking member on the first axis, by pivoting of the link member relative to the first con rod on the third axis, and by pivoting of the rocking member relative to the second con rod on the fourth axis; wherein the mountings comprise an opening defined by the rocking member or by a fitting secured to the rocking member; and wherein the holding means includes an adjusting shaft or axle having an axis co-incident with the first axis on which it is rotatable relative to the rocking member, an eccentric rotatable with the adjusting shaft or axle to orbit around the first axis and a holding arm which is journalled at one end on the eccentric and extends therefrom radially with respect to the first axis to a pivotable coupling between its other end and the link member, whereby the holding arm is moved with orbiting of the eccentric in response to rotation of the adjusting shaft or axle to pivot the link member on the second axis relative to the rocking member; and wherein the engine includes means drivingly connecting the adjusting shaft and the crankshaft to provide a fixed rotational ratio of one to two respectively, whereby said engine is operable with an Atkinson Cycle motion.

60. The engine of any one of claims 57 to 59, wherein the plurality of cylinders are in-line in a first bank of a V-type configuration, with the engine including a further plurality of cylinders in-line in a second bank.